Review Article

Comparison of Outcomes following Vaginal Natural Orifice Transluminal Endoscopic Surgery and Laparoendoscopic Single-site Surgery in Benign Hysterectomy: A Systematic Review and Meta-analysis

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Abstract

Gradually increasing interest in laparoscopic surgeries has led to the advent of various lesser invasive techniques in the form of vaginal natural orifice transluminal endoscopic surgery (vNOTES) and laparoendoscopic single-site (LESS) surgery. Very few studies have analyzed the advantages and disadvantages of vNOTES over LESS surgeries in hysterectomy. After a comprehensive search, full texts of relevant manuscripts were obtained to assess eligibility for recruitment. A comprehensive meta-analysis was subsequently performed to compare the outcomes of vNOTES and LESS in hysterectomy, and forest plots were constructed. Four articles were rendered for review (three retrospective cohort studies and one randomized controlled trial). Three studies showed lesser postoperative pain in vNOTES compared to LESS. In one study, postoperative vaginal pain was higher in vNOTES due to additional suture between uterine artery and vaginal wall. The meta-analysis concluded that vNOTES could be better alternative to LESS hysterectomies. However, further large multicentric randomized trials are required for the standardization of the surgical method.

Keywords: Benign hysterectomy, laparoendoscopic single-site surgery, minimally invasive gynecologic surgery, vaginal natural orifice transluminal endoscopic surgery

Introduction

Over the past few years, minimally invasive surgery has gained more importance and has become a common procedure in gynecological surgeries. Gradually increasing interest in laparoscopic and robotic surgical techniques has led to the advent of various other lesser invasive surgeries such as vaginal natural orifice transluminal endoscopic surgery (vNOTES) and laparoendoscopic single-site (LESS) surgeries in gynecology. Besides being technically challenging, there is no strong evidence to recommend the use of vNOTES and LESS over conventional three- or four-port laparoscopy till date. Recently, few studies were carried out to analyze their feasibility, safety, advantages, and disadvantages over conventional surgical techniques. Only a handful of them compared the risks and benefits of vNOTES over LESS in modern gynecology. The main objective of this review was to comprehend and solidify a detailed quantitative deduction as to whether vNOTES is superior to LESS in terms of operative and postoperative

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outcomes pertaining to gynecological surgeries such as hysterectomy.

Aims and Objectives

In this review, we aimed to compare the operative and postoperative outcomes of vNOTES and LESS in benign hysterectomy by means of a comprehensive search of literature.

Methodology

This review was prospectively registered in the PROSPERO before the initiation of the study (CRD42022340381).[1] The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 statement was followed for conducting and reporting this systematic review and meta-analysis.[2] An extensive search was done to retrieve the published literature on the comparison of vNOTES over LESS surgeries in minimally invasive gynecology. The review was performed in the following steps:

a. Determining the research question
b. Literature search to identify relevant published studies
c. Selecting the studies appropriate for recruitment in the review
d. Classifying and summarizing the data in a tabular form
e. Reporting the relevant results.

Determining the research question

We designed the research question as whether vNOTES is superior to LESS surgical techniques in terms of reduced intra- and postoperative complications pertaining to hysterectomy.

Search strategy

A predefined search strategy was followed using a combination of keywords: ([Natural Orifice Transluminal Endoscopic Surgery] AND [Laparoendoscopic single site surgery]) published in databases: PubMed, Embase, Scopus, Google Scholar, and Clinical Trial registry bodies, for example, Clinical Trials Registry of India since inception till June 2022. The full texts of relevant manuscripts were obtained to assess and analyze their eligibility for recruitment into the review. For articles not being captured by electronic search, we extracted data by doing a manual search using the references in the original articles. PRISMA 2020 statement was used for including the relevant studies for the review [Figure 1].

Inclusion criteria

The following inclusion criteria were considered in this review: (1) human scientific trials; (2) no specific linguistic

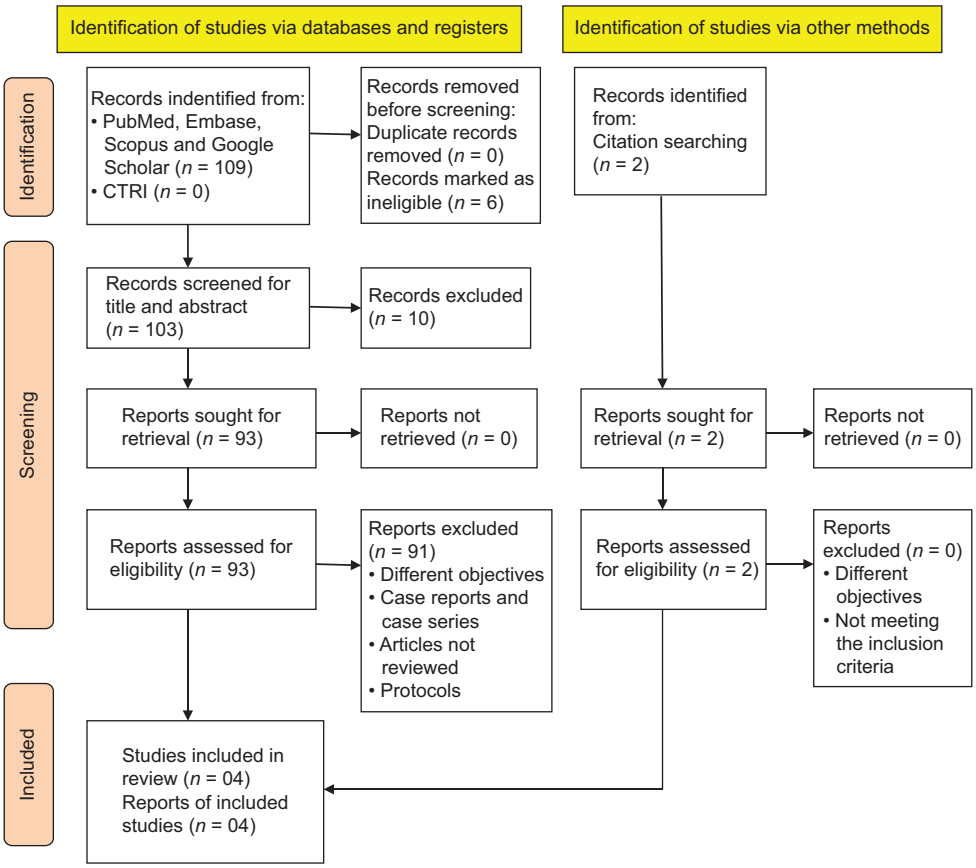

Figure 1: PRISMA 2020 flow diagram showing the process of recruitment of the included studies. PRISMA: Preferred Reporting Items for Systematic reviews and Meta-Analyses

restrictions; (3) studies comparing the safety, efficacy, advantages, or disadvantages of vNOTES and LESS surgery in hysterectomy; and (4) single- or multicenter randomized or quasi-randomized controlled trials (RCTs), prospective or retrospective cohort studies, and case–control study designs.

Exclusion criteria

Articles with at least one of the following criteria were excluded from this review:

- Study protocols or trials without results
- Articles in preprint
- Case series, case reports, and cross-sectional studies
- Studies assessing the perioperative safety and efficacy of vNOTES or LESS surgeries other than those related to hysterectomy procedures.

Selecting studies appropriate for recruitment in the review

Two authors (AS and SP) extracted all eligible abstracts independently in agreement with the criteria of selection. To gain the final decision on inclusion or exclusion, the full-text manuscripts of the studies fulfilling the selection criteria were reviewed in detail. Any disagreement with regard to study eligibility was resolved after discussion and consensus with the third and fourth authors (RZ and KKR).

Data extraction

Information was collected on the objective of the study, its design, sample size, variables related to age, parity, body mass index (BMI), any history of previous surgeries, and volume or weight of uterus or ovarian cysts removed through vNOTES or LESS surgery. Data pertaining to the comparison of operative time, intraoperative blood loss or hemoglobin drop, duration of hospital stay, intra- and postoperative complications, need for conversion to open surgery, need for perioperative analgesia, and pain scores using a Visual Analog Scale (VAS) were also noted. The studies were evaluated and assessed to ensure that the minimum quality standards were met.

Quality assessment

Methodological quality of the studies was assessed according to the Cochrane Systematic Review guidelines. All recruited studies were checked by AS and SP separately. Any difference in opinion was sorted out after discussion with RZ and KKR.

Reporting the relevant results and summarizing the data in a tabular form

After selection of the relevant studies, the obtained data were tabulated in Tables 1 and 2. A comprehensive meta-analysis was performed to assess whether vNOTES was superior to LESS surgery in terms of operative time, intraoperative blood loss, duration of hospital stay, and postoperative pain and need for analgesia. The results of the relevant data were summarized and reported.

Results

Study characteristics

The initial search using the keywords: ([Natural Orifice Transluminal Endoscopic Surgery] AND [Laparoendoscopic single site surgery]) identified a total of 109 studies through searching through databases and clinical registries and two studies through manual searching of citations [Figure 1]. The database search was carried out as follows:

1. Natural orifice transluminal endoscopic surgery ($n = 5425$)
2. LESS surgery ($n = 1162$)
3. #1 AND #2 ($n = 109$).

After screening the title and abstract, 103 studies were included. After excluding the nonrelevant studies, a total

Table 1: Comparing the baseline parameters in the included studies

Parameters	Yang *et al*. (2014)	Chen *et al*. (2020)	Basol *et al*. (2021)	Park *et al*. (2021)
Study design	Retrospective cohort study	Retrospective cohort study	Retrospective cohort study	Randomized controlled trial
Sample size	48 (vNOTES: 16 LESS: 32)	107 (vNOTES: 30 LESS: 77)	60 (vNOTES: 20 LESS: 40)	26 (vNOTES: 13 LESS: 13)
Type of surgery performed	Hysterectomy	Hysterectomy	Hysterectomy	Hysterectomy
Mean age (years)	vNOTES: 47.3±4.6 LESS: 45.8±5.4	vNOTES: 49.6±3.8 LESS: 48.2±7.6	vNOTES: 49.8±5.2 LESS: 49.1±5.7	Median age vNOTES: 54 (35-77) LESS: 48 (34-63)
BMI	vNOTES: 23.8±2.3 LESS: 23.9±3.7	vNOTES: 21.3±3.5 LESS: 22.0±4.2	vNOTES: 26.9±4.3 LESS: 27.1±3.7	Median BMI vNOTES: 23.8 (21.3-27.6) LESS: 21.8 (20.2-25.9)
Parity	vNOTES: 2 (0-3) LESS: 2 (0-4)	-	vNOTES: 2.85±1.09 LESS: 2.90±1.41	-
Proportion of patients with history of previous abdominal surgery	vNOTES: 7 out of 16 LESS: 11 out of 32	-	vNOTES: 5 out of 20 LESS: 17 out of 40	vNOTES: 4 out of 13 LESS: 3 out of 13
Weight or volume of uterus or ovarian cyst being removed	Uterine weight (g) vNOTES: 299.4±186 LESS: 23.9±3.7	Uterine volume (cc) vNOTES: 165±36 LESS: 235±38	Uterine volume (cc) vNOTES: 103.9±16.3 LESS: 104.8±24.9	Uterine weight (g) vNOTES: 238 (40.8-940) LESS: 196 (93-346)

vNOTES: Vaginal natural orifice transluminal endoscopic surgery, LESS: Laparoendoscopic single site, BMI: Body mass index

Table 2: Comparing the outcome parameters of the included studies

Parameters	Yang *et al*. (2014)	Chen *et al*. (2020)	Basol *et al*. (2021)	Park *et al*. (2021)
Operative time (min)	vNOTES: 70.6±12.8 LESS: 93.2±21.4 (statistically significant)	vNOTES: 150±41 LESS: 169±48	vNOTES: 58.5±14.2 LESS: 64.2±16.7	vNOTES: 55 (25-105) LESS: 75 (50-110) (statistically significant)
Estimated blood loss (mL)	vNOTES: 201.8±127 LESS: 228.1±172	vNOTES: 54±15 LESS: 54±14	-	vNOTES: 100 (0-650) LESS: 100 (0-300)
Hemoglobin drop (g/dL)	At day 1 postoperative: vNOTES: 1.05±1.06 LESS: 1.42±1.07	-	At day 1 postoperative: vNOTES: 1.2±0.4 LESS: 1.5±0.7	Median blood loss at day 1 postoperative: vNOTES: 1.5 LESS: 1.5
Duration of hospital stay (days)	vNOTES: 3.5 (3-5) LESS: 4 (3-6) (statistically significant)	vNOTES: 3.2±0.8 LESS: 3.6±0.9 (statistically significant)	vNOTES: 1.3±0.3 LESS: 1.8±0.3 (statistically significant)	vNOTES: 4 (4-4) LESS: 4 (4-5)
Need for analgesia (median number of doses)	vNOTES: 0 (0-6) LESS: 1 (0-5)	-	-	vNOTES: 1 (0-3) LESS: 1 (0-3)
Pain score using VAS	At 12 h postoperative: vNOTES: 2 (0-6) LESS: 2 (0-5) At 24 h postoperative: vNOTES: 0 (0-4) LESS: 0.5 (0-8)	-	At 1 h postoperative: vNOTES: 3.7±1.3 LESS: 4.5±1.2 (statistically significant) At 18 h postoperative: vNOTES: 1.2±0.6 LESS: 1.8±0.7 (statistically significant)	At 8 h postoperative Abdominal pain: vNOTES: 3 (0-6) LESS: 3 (0-6) Vaginal pain: vNOTES: 3 (0-5) LESS: 1 (0-4) At 18 h postoperative Abdominal pain: vNOTES: 2 (0-3) LESS: 3 (1-5) Vaginal pain (statistically significant) vNOTES: 2 (0-3) LESS: 0 (0-2)
Other parameters	-	Faster urinary catheter removal in vNOTES group compared to LESS (1.9±0.4 vs. 2.3±0.6 days) Faster intestinal recovery in the vNOTES group compared to LESS (1.7±0.5 vs. 2.3±0.6 days)	Lesser postoperative complication in vNOTES group compared to LESS surgery group (0 vs. 9 patients)	-
Inference	NOTES assisted vaginal hysterectomy is a feasible and safe surgical technique with shorter operative time and postoperative hospital stay compared to single port laparoscopy assisted vaginal hysterectomy	Both LESS and vNOTES are safe and feasible for total hysterectomy. Compared to LESS, vNOTES may be a promising approach with earlier recovery, less injury and better cosmesis	vNOTES could be a prominent alternative approach to other minimally invasive surgical procedures in selected patients with advantages of lesser pain and lower complication rates	vNOTES hysterectomy is a safe alternative to LESS surgery. However, it might be associated with higher postoperative vaginal pain intensity compared to LESS hysterectomy

NOTES: Natural orifice transluminal endoscopic surgery, vNOTES: Vaginal NOTES, LESS: Laparoendoscopic single site

of 95 studies (93 through databases and 2 through manual retrieval) were assessed for eligibility. A careful analysis of the eligible text resulted in four articles being rendered out for the review [Figure 1].

Description of the included studies

Among the four studies, three were retrospective cohort studies,[3-5] and one was a single-center RCT (pilot study).[6] Among them, two studies were from Korea,[3,6] one from China,[4] and one from Turkey.[5] None of the studies were multicentric. The details of the study design, population under study, interventions, study outcome, and data assessment reporting are shown in Tables 1 and 2. The sample size varied from 26 to 107 among the included studies, with a total of 241 women being recruited for this review [Table 1]. All four studies analyzed the benefits and risks of vNOTES and LESS in hysterectomy.[3-6] The mean age ranged from 45.8 to 49.8 years. Women in the study population belonged to normal to overweight category with a BMI ranging from 21.1 to 27.1 kg/m^2. The mean operative time ranged from 55 to 70.6 ± 12.8 min in vNOTES and from 75 to 93.2 ± 21.4 min in LESS hysterectomy [Table 2]. The median postoperative stay ranged from 3.2 ± 0.8 to 4 days in vNOTES and from 3.6 ± 0.9 to 4 days in LESS hysterectomy. Among the four studies, two used VAS to assess the postoperative pain[3,5] and

one study used the Numerical Rating Scale.[6] Yang *et al*. and Park *et al*. stated that there was no significant difference in postoperative abdominal pain in both the groups.[3,6] However, Park *et al*. noted that the vaginal pain was higher in the vNOTES group.[6] The higher vaginal pain was substantiated to the additional suturing between uterine artery and vaginal wall to control bleeding while securing the vaginal cuff. Park *et al*. were the first to analyze the postoperative pain as abdominal and vaginal separately.[6] Yang *et al*. and Park *et al*. stated that the duration of surgery was significantly lesser in vNOTES compared to LESS hysterectomy.[3,6] However, no difference was noted in the duration of surgery by Chen *et al*. and Basol *et al*.[4,5] All four studies demonstrated that there were no significant differences in estimated blood loss during surgery or fall in hemoglobin in the postoperative blood count analysis. Yang *et al*. observed that the postoperative stay was lesser in vNOTES.[3] There was no conversion to conventional laparoscopy or laparotomy in Yang *et al*. However, Basol *et al*. observed a conversion to conventional laparoscopy in four out of forty patients in the LESS group.[5] On the other hand, two out of twenty cases in the vNOTES group required conversion to vaginal hysterectomy.[5]

Yang *et al*. and Park *et al*. observed no significant difference in blood transfusion between both the groups.[3,6] Basol *et al*. stated the need for blood transfusion in two among the forty in the LESS group.[5] There was no difference in the requirement of additional analgesics in studies by Yang *et al*. and Park *et al*.[3,6] Basol *et al*. stated that postoperative pain was better with vNOTES compared to LESS ovarian cystectomy and hysterectomy,[5] while Park *et al*. concluded that the postoperative vaginal pain was higher in vNOTES compared to LESS hysterectomy.[6]

Methodological quality of the included studies

The authors assessed the quality of recruited studies with the aid of Joanna Briggs Institute (JBI) critical appraisal checklist.[7] The quality assessment of all the four retrospective cohort studies was done separately, as shown in Table 3. The risk of bias summary was assessed for each study separately, and the respective graphs were plotted using RevMan version 5.4 [Figure 2]. The graphs depict the summary of the calculated risk of bias (low risk of bias is shown with green, unclear risk with yellow, and high risk with red color, respectively).

During quality assessment, all three retrospective cohort studies were found to have a low risk of bias in terms of selection of exposed and nonexposed cohorts from the same population.[3-5] When the assessment of exposure was analyzed in the studies, Yang *et al*. and Chen *et al*. were rated to have low risk of bias.[3,4] However, the assessment of exposure was unclear in the studies by Basol *et al*.[5] None of the studies have clearly mentioned whether the confounding factors were identified and what strategies were adopted to deal with them. Similarly, no mention was done whether the outcome of interest was absent at the start of the study. Yang *et al*. have clearly mentioned about matching of exposed and nonexposed groups.[3] It was not clear from the study designs of Chen *et al*. and Basol *et al.* whether matching was ever done.[4,5] Publication bias could not be assessed in this systematic review.

None of the studies have mentioned about the presence of any prognostic factors among the exposed and nonexposed groups. Outcome assessment was proper in all the four retrospective studies and was thus rated low risk. Yang *et al*. did not mention any strategy to address the incomplete follow-up of their cohorts,[3] whereas it was unclear in case of Chen *et al*. and Basol *et al*.[4,5] Statistical analyses were proper in all three studies. Finally, no similarity in co-interventions was clearly present between groups in studies done by Chen *et al*. and Basol *et al.* [Table 3].

The RCT by Park *et al*.[6] was also rated according to JBI critical appraisal checklist [Table 4]. It was rated to have low risk of selection bias as randomization and allocation concealment were proper in the study methodology. However,

Table 3: Quality assessment of included cohort studies using JBI critical appraisal checklist

	Yang *et al*.[3]	Chen *et al*.[4]	Basol *et al*.[5]
Were the two groups similar and recruited from the same population?	Yes	Yes	Yes
Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Yes	Yes	Unclear
Was the exposure measured in a valid and reliable way?	Yes	Yes	Unclear
Were confounding factors identified?	Unclear	Unclear	Unclear
Were strategies to deal with confounding factors stated?	Unclear	Unclear	Unclear
Were the groups free of the outcomes at the start of the study?	Unclear	Unclear	Unclear
Were the outcomes measured in a valid and reliable way?	Yes	Yes	Yes
Was the follow-up time reported and sufficient to be long enough for outcome to occur?	No	Unclear	Unclear
Was follow-up complete?	No	No	No
Were strategies to address incomplete follow-up utilized?	No	Unclear	Unclear
Was appropriate statistical analysis used?	Yes	Yes	Yes

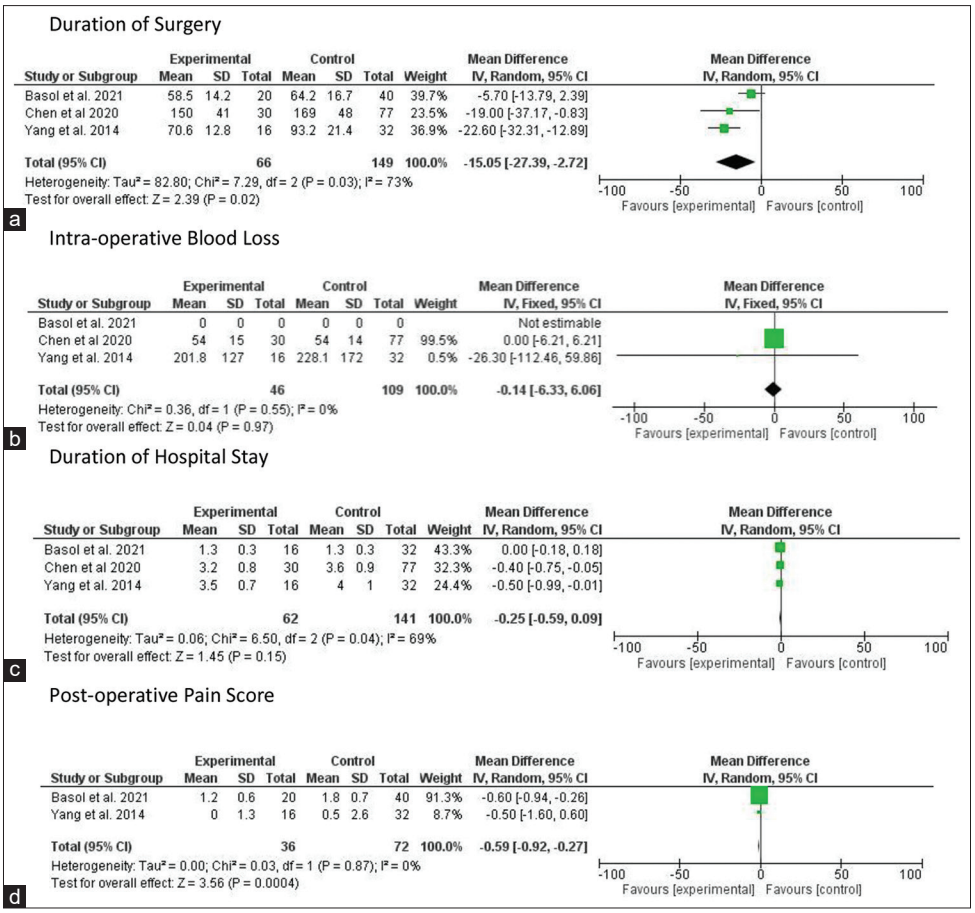

Figure 2: Forest plot depicting the results of the meta-analysis. (a) Duration of surgery, (b) Intra-operative blood loss, (c) Duration of hospital stay, (d) Postoperative pain score

Table 4: Quality assessment of included randomized controlled trial using JBI critical appraisal checklist

	Park *et al*.[6]
Was true randomization used for assignment of participants to treatment groups?	Yes
Was allocation to treatment groups concealed?	Yes
Were treatment groups similar at the baseline?	Yes
Were participants blind to treatment assignment?	No
Were those delivering treatment blind to treatment assignment?	No
Were outcome assessors blind to treatment assignment?	No
Were treatment groups treated identically other than the intervention of interest?	Yes
Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Unclear
Were participants analyzed in the groups to which they were randomized?	Yes
Were outcomes measured in the same way for treatment groups?	Yes
Were outcomes measured in a reliable way?	Yes
Was appropriate statistical analysis used?	Yes
Was the trial design appropriate, and any deviations from the standard RCT design accounted for in the conduct and analysis of the trial?	Yes

RCT: Randomized controlled trial

blinding of the participants and gynecologist was not done because of the nature of the study and so was rated to have high risk. Detection and attrition bias were unclear in the study as no proper mention was made regarding the blinding of the outcome assessments and follow-up of the data. Finally, there was no reporting bias, and the study was rated to have low risk for the same [Table 4].

Comprehensive meta-analysis

A meta-analysis was conducted on the quantitative analysis of the data obtained from the three retrospective cohort studies.[3-5] The study by Park *et al*. being the only RCT (with different study designs) could not be included in the meta-analysis.[6] The evaluation included comparisons between outcome parameters in the form of duration of

surgery, intraoperative blood loss, duration of hospital stay, and postoperative pain scores [Figure 2]. The forest plot depicts that the duration of surgery and postoperative pain scores are significantly lesser in vNOTES hysterectomy compared to LESS hysterectomy [Figure 2].

Discussion

With the increased practice of minimally invasive surgeries and considering their benefits in terms of operative and postoperative events, the practice of gynecological surgeries is gradually getting revolutionized to even lesser invasive ones such as vNOTES and LESS. While LESS involves the entry and instrumentation inside the abdomen through a single port, the evolving body of knowledge eliminated the concept of entry into the abdomen with the introduction of vNOTES. vNOTES has many advantages which actually ease the gynecological surgeries. In case of adnexal surgeries, the natural anatomy of the adnexa located relatively lower in the cul-de-sac makes them obvious to easy access by vNOTES.[8] The colpotomy incision, being elastically distensible, is easier to remove solid masses such as teratomas or fibromas. vNOTES requires a special learning curve to achieve the actual benefit of the procedure. Huang *et al*. suggested that a gynecologic endoscopist can achieve a good surgical competency in vNOTES cystectomy after 36 cases.[8] They also suggested that the vNOTES should begin with adnexectomy rather than cystectomy to circumvent the initial technical difficulties. The crucial step for successful vNOTES is culdotomy. Culdotomy is the safest conventional procedure to gain access into the peritoneal cavity with 1.3% incidence of complications such as injury of the rectum, vaginal bleeding, hematoma, vaginal scar, and postoperative infection.[9] Identification of anatomical landmarks such as triangle of safety can cut down the risk of injury to the adjoining structures.[10] A relatively greater postoperative vaginal pain after vNOTES can be attributed to its incision over the vaginal vault which is innervated by the visceral nerves. Others factor being consistent, the postoperative abdominal pain should be lesser in vNOTES compared to the conventional skin incision. Baekelandt *et al*. analyzed postoperative pain with VAS score following vNOTES versus conventional laparoscopic hysterectomy and found that the VAS score was lesser in the vNOTES group.[11] The operative time was lesser in the vNOTES group compared to LESS.[12] This lesser time might be due to the avoidance of opening and closure of the umbilical incision. Nulens *et al*. concluded that hysterectomy was done by vNOTES in 99% of the cases without the need of conversion to open or vaginal hysterectomy.[13] The other important concern in laparoscopic surgery is port site hernia and its incidence at the umbilicus which ranges from 0.8% to 2.2%.[14] It is known that umbilical port site hernia is more common in LESS compared to conventional laparoscopy surgery.[15] There are reported cases of serosal injury to stomach and adjacent organs during port entry which are prevented in vNOTES.[16] Moreover, vNOTES is nowadays assessed for its feasibility in surgical staging of carcinoma endometrium as well.[17] Basol *et al*. concluded that the only difference between LESS and conventional laparoscopy is the number of ports and abdominal wall damage, the other surgical steps being the same.[5] Hence, LESS should not be considered an excellent technique though it is an alternate to conventional three- or four-port laparoscopy. They have also concluded that vNOTES can be considered an alternative choice to other minimally invasive procedures with lesser postoperative pain and other complications compared to LESS.[5] Considering the health economic benefits, vNOTES can be done by two doctors, whereas LESS requires two to three expert surgeons.[5] Baekelandt *et al*. showed that the same instruments used in LESS and conventional laparoscopy can be used for vNOTES.[11] The length of hospital stay was also significantly shorter in vNOTES compared to LESS hysterectomy.[3-6]

Strengths

Data collection in all the studies was meticulous and organized. The study by Park *et al*. was a properly designed RCT.[6] Proper scoring systems were used for assessing the postoperative pain in almost all the studies. This meta-analysis is the first to compare the operative and postoperative outcomes of vNOTES hysterectomy over LESS hysterectomy.

Limitations

All studies were based on single-center data. No multicentric trials have been performed on this subject till date. Most of the studies were retrospective cohort studies.[3-5] Lack of RCTs other than Park *et al*.[6] warrants the need for conducting more randomized trials on this subject. Smaller sample size of 26 by Park *et al*. was because it was a pilot study.[6] Since the meta-analysis could be done only on retrospective cohort studies, so the risk of bias also remains high. The other limitation is the use of patient-controlled analgesia in the study by Park *et al*., which might have hindered the difference in postoperative pain scores.[6] The application of additional suturing in the study by Park *et al*. may have affected the primary outcome measures.

Conclusion

The meta-analysis has shown that the duration of surgery and postoperative abdominal pain scores were significantly lesser in vNOTES hysterectomy compared to LESS hysterectomy. However, RCT by Park *et al*.[6] demonstrated an increase in

postoperative vaginal pain in vNOTES arm as compared to LESS hysterectomy which could be attributed to the additional sutures between the uterine artery and the vaginal wall. Considering this, we conclude that vNOTES could be a better alternative to other minimally invasive hysterectomies, but further large multicentric RCTs are required for the standardization of the surgical method.

Acknowledgments

We sincerely thank Dimple Rawat for her help in the quality assessment of the included studies with the aid of JBI critical appraisal checklist and plotting the RevMan version 5.4 graphs for each study, respectively.

Ethics approval

This review has been registered in the PROSPERO well before the initiation of the study (CRD42022340381).

Consent to publish

This study being a systematic review, no human participants were directly involved in this study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Available from: https://www.crd.york.ac.uk/prospero/. [Last accessed on 2023 Feb 02].
2. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. BMJ 2009;339:b2535.
3. Yang YS, Kim SY, Hur MH, Oh KY. Natural orifice transluminal endoscopic surgery-assisted versus single-port laparoscopic-assisted vaginal hysterectomy: A case-matched study. J Minim Invasive Gynecol 2014;21:624-31.
4. Chen L, Zheng Y, Min L, Dong SM. Clinical cohort study of total hysterectomy via transvaginal natural orifice transluminal endoscopic surgery and transumbilical laparoendoscopic single site surgery. Zhonghua Fu Chan Ke Za Zhi 2020;55:843-7.
5. Basol G, Cora AO, Gundogdu EC, Mat E, Yildiz G, Kuru B, *et al.* Hysterectomy via transvaginal natural orifice transluminal endoscopic surgery versus single-port laparoscopy: Comparison of early outcomes. J Obstet Gynaecol Res 2021;47:3288-96.
6. Park SJ, Kim HS, Yim GW. Comparison of vaginal natural orifice transluminal endoscopic surgery (vNOTES) and laparoendoscopic single-site (LESS) hysterectomy on postoperative pain reduction: A randomized pilot study. Pain Ther 2021;10:1401-11.
7. Available from: https://jbi.global/critical-appraisal-tools-2020. [Last accessed on 2022 Jun 28].
8. Huang YT, Yang LY, Pan YB, Huang HY, Wu KY, Wang CJ, *et al.* Learning curve analysis of transvaginal natural orifice adnexal surgery. J Minim Invasive Gynecol 2020;27:489-97.
9. Tolcher MC, Kalogera E, Hopkins MR, Weaver AL, Bingener J, Dowdy SC. Safety of culdotomy as a surgical approach: Implications for natural orifice transluminal endoscopic surgery. JSLS 2012;16:413-20.
10. Roberts K, Solomon D, Bell R, Duffy A. "Triangle of safety": Anatomic considerations in transvaginal natural orifice surgery. Surg Endosc 2013;27:2963-5.
11. Baekelandt JF, De Mulder PA, Le Roy I, Mathieu C, Laenen A, Enzlin P, *et al.* Hysterectomy by transvaginal natural orifice transluminal endoscopic surgery versus laparoscopy as a day-care procedure: A randomised controlled trial. BJOG 2019;126:105-13.
12. Kaya C, Yıldız Ş, Alay İ, Aslan Ö, Aydıner İE, Yaşar L. The comparison of surgical outcomes following laparoscopic hysterectomy and vNOTES hysterectomy in obese patients. J Invest Surg 2022;35:862-7.
13. Nulens K, Bosteels J, De Rop C, Baekelandt J. vNOTES hysterectomy for large uteri: A retrospective cohort study of 114 patients. J Minim Invasive Gynecol 2021;28:1351-6.
14. Nassar AH, Ashkar KA, Rashed AA, Abdulmoneum MG. Laparoscopic cholecystectomy and the umbilicus. Br J Surg 1997;84:630-3.
15. Connell MB, Selvam R, Patel SV. Incidence of incisional hernias following single-incision versus traditional laparoscopic surgery: A meta-analysis. Hernia 2019;23:91-100.
16. Chen PC, Li PC, Chen H, Ding DC. Serosal injury to a distended stomach during open entry for laparoendoscopic single-site surgery. Gynecol Minim Invasive Ther 2022;11:121-3.
17. Lee CL, Liu HM, Khan S, Lee PS, Huang KG, Yen CF. Vaginal natural orifice transvaginal endoscopic surgery (vNOTES) surgical staging for endometrial carcinoma: The feasibility of an innovative approach. Taiwan J Obstet Gynecol 2022;61:345-52.